Computer-Aided VLSI System Design
Homework 5 Report

Due Tuesday, Dec. 5, 14:00

Student ID:

Student Name:

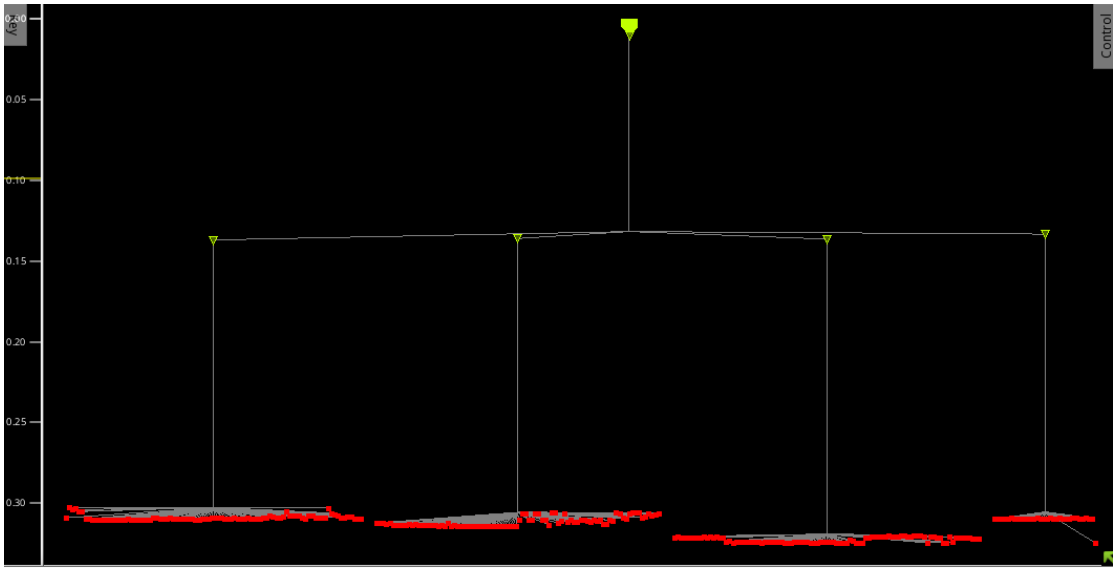
APR Results

1. Fill in the blanks below.

Design Stage	Description	Value
P&R	Number of DRC violations (ex: 0) (Verify -> Verify Geometry…)	0
	Number of LVS violations (ex: 0) (Verify -> Verify Connectivity…)	0
	Die Area (um^2)	489062.43
	Core Area (um^2)	290445.51
Post-layout Simulation	Clock Period for Post-layout Simulation (ex. 10ns)	10ns
Follow your design in HW3? (If not, specify student ID of the designer or 'from TA')		From TA

Questions and Discussion

1. Attach the snapshot of CCOpt Clock Tree Debugger result (5%).



Clock Path Browser — cad29.ee.ntu.edu.t

Timing Corner	Skew Group	Skew	Min Delay	Max Delay	Min Pin	MinPath Level	Max Pin	MaxPath Level
Delay_Corner_max:both.early								
	i_clk/func_mode	0.022	0.298	0.320	...r_r_reg_0__1_/CK	4	...r_r_reg_5__7_/CK	4
Delay_Corner_max:both.late								
	i_clk/func_mode	0.022	0.298	0.320	...r_r_reg_0__1_/CK	4	...r_r_reg_5__7_/CK	4

2. Attach the snapshot of DRC and LVS checking after routing. (5%)

```
*** Starting Verify DRC (MEM: 2879.0) ***

  VERIFY DRC ..... Starting Verification
  VERIFY DRC ..... Initializing
  VERIFY DRC ..... Deleting Existing Violations
  VERIFY DRC ..... Creating Sub-Areas
  VERIFY DRC ..... Using new threading
  VERIFY DRC ..... Sub-Area: {0.000 0.000 176.800 176.800} 1 of 16
  VERIFY DRC ..... Sub-Area : 1 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {176.800 0.000 353.600 176.800} 2 of 16
  VERIFY DRC ..... Sub-Area : 2 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {353.600 0.000 530.400 176.800} 3 of 16
  VERIFY DRC ..... Sub-Area : 3 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {530.400 0.000 699.200 176.800} 4 of 16
  VERIFY DRC ..... Sub-Area : 4 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {0.000 176.800 176.800 353.600} 5 of 16
  VERIFY DRC ..... Sub-Area : 5 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {176.800 176.800 353.600 353.600} 6 of 16
  VERIFY DRC ..... Sub-Area : 6 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {353.600 176.800 530.400 353.600} 7 of 16
  VERIFY DRC ..... Sub-Area : 7 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {530.400 176.800 699.200 353.600} 8 of 16
  VERIFY DRC ..... Sub-Area : 8 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {0.000 353.600 176.800 530.400} 9 of 16
  VERIFY DRC ..... Sub-Area : 9 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {176.800 353.600 353.600 530.400} 10 of 16
  VERIFY DRC ..... Sub-Area : 10 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {353.600 353.600 530.400 530.400} 11 of 16
  VERIFY DRC ..... Sub-Area : 11 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {530.400 353.600 699.200 530.400} 12 of 16
  VERIFY DRC ..... Sub-Area : 12 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {0.000 530.400 176.800 699.460} 13 of 16
  VERIFY DRC ..... Sub-Area : 13 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {176.800 530.400 353.600 699.460} 14 of 16
  VERIFY DRC ..... Sub-Area : 14 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {353.600 530.400 530.400 699.460} 15 of 16
  VERIFY DRC ..... Sub-Area : 15 complete 0 Viols.
  VERIFY DRC ..... Sub-Area: {530.400 530.400 699.200 699.460} 16 of 16
  VERIFY DRC ..... Sub-Area : 16 complete 0 Viols.

  Verification Complete : 0 Viols.

 *** End Verify DRC (CPU: 0:00:01.1  ELAPSED TIME: 1.00  MEM: 257.1M) ***
```

```
******** End: VERIFY CONNECTIVITY ********
  Verification Complete : 0 Viols.  0 Wrngs.
  (CPU Time: 0:00:00.3  MEM: 0.000M)
```

3. Attach the snapshot of the timing report for **setup time and hold time** with no timing violation (post-route). (5%)

```
------------------------------------------------------------------
     optDesign Final SI Timing Summary
------------------------------------------------------------------

Setup views included:
 av_func_mode_max
Hold views included:
 av_func_mode_max

+--------------------+---------+---------+---------+---------+---------+---------+
|     Setup mode     |   all   | reg2reg | in2reg  | reg2out | in2out  | default |
+--------------------+---------+---------+---------+---------+---------+---------+
|           WNS (ns):|  0.060  |  0.242  |  0.060  |  1.328  |   N/A   |  0.000  |
|           TNS (ns):|  0.000  |  0.000  |  0.000  |  0.000  |   N/A   |  0.000  |
|    Violating Paths:|    0    |    0    |    0    |    0    |   N/A   |    0    |
|          All Paths:|   649   |   319   |   427   |   16    |   N/A   |    0    |
+--------------------+---------+---------+---------+---------+---------+---------+

+--------------------+---------+---------+---------+---------+---------+---------+
|     Hold mode      |   all   | reg2reg | in2reg  | reg2out | in2out  | default |
+--------------------+---------+---------+---------+---------+---------+---------+
|           WNS (ns):|  0.769  |  0.769  |  2.812  |  3.124  |   N/A   |  0.000  |
|           TNS (ns):|  0.000  |  0.000  |  0.000  |  0.000  |   N/A   |  0.000  |
|    Violating Paths:|    0    |    0    |    0    |    0    |   N/A   |    0    |
|          All Paths:|   649   |   319   |   427   |   16    |   N/A   |    0    |
+--------------------+---------+---------+---------+---------+---------+---------+

+----------------+-------------------------------+------------------+
|                |              Real             |       Total      |
|    DRVs        +------------------+------------+------------------|
|                |  Nr nets(terms)  | Worst Vio  |  Nr nets(terms)  |
+----------------+------------------+------------+------------------+
|   max_cap      |      0 (0)       |   0.000    |      0 (0)       |
|   max_tran     |      0 (0)       |   0.000    |      0 (0)       |
|   max_fanout   |      0 (0)       |     0      |      0 (0)       |
|   max_length   |      0 (0)       |     0      |      0 (0)       |
+----------------+------------------+------------+------------------+
```

4. Show the critical path after post-route optimization. What is the path type? (10%)
   (The slack of the critical path should match the smallest slack in the timing report)

```
#############################################################
Path 1: MET Setup Check with Pin o_out_data_r_reg_2_/CK
Endpoint:   o_out_data_r_reg_2_/D (^) checked with  leading edge of 'i_clk'
Beginpoint: i_in_valid            (v) triggered by  leading edge of 'i_clk'
Path Groups: {in2reg}
Analysis View: av_func_mode_max
Other End Arrival Time          0.500
- Setup                         0.253
+ Phase Shift                   5.000
+ CPPR Adjustment               0.000
= Required Time                 5.247
- Arrival Time                  5.187
= Slack Time                    0.060
     Clock Rise Edge                      0.000
     + Input Delay                        2.500
     + Network Insertion Delay            0.500
     = Beginpoint Arrival Time            3.000
     +-------------------------------------------------------------------------------+
     |      Instance       |     Arc      |   Cell   | Delay | Arrival | Required |
     |                     |              |          |       |  Time   |   Time   |
     |---------------------+--------------+----------+-------+---------+----------|
     |                     | i_in_valid v |          |       |   3.000 |    3.060 |
     | U3330               | B v -> Y v   | AND2X2   | 0.182 |   3.182 |    3.242 |
     | U1688               | AN v -> Y v  | NAND2BX1 | 0.181 |   3.363 |    3.423 |
     | U3354               | A0 v -> Y ^  | AOI22X1  | 0.138 |   3.501 |    3.561 |
     | FE_RC_212_0         | AN ^ -> Y ^  | NOR2BX1  | 0.179 |   3.680 |    3.740 |
     | FE_RC_211_0         | B ^ -> Y v   | NAND3X1  | 0.144 |   3.824 |    3.884 |
     | U3053               | C v -> Y ^   | NAND3X2  | 0.158 |   3.982 |    4.042 |
     | U1493               | A ^ -> Y v   | INVX3    | 0.071 |   4.054 |    4.114 |
     | U2115               | A0 v -> Y ^  | OAI211X1 | 0.176 |   4.229 |    4.289 |
     | U1679               | B ^ -> Y ^   | OR2X1    | 0.244 |   4.473 |    4.533 |
     | U1683               | A ^ -> Y v   | INVX1    | 0.151 |   4.625 |    4.685 |
     | U1954               | B v -> Y v   | OR2X1    | 0.279 |   4.904 |    4.964 |
     | U1956               | A v -> Y v   | AND2X2   | 0.161 |   5.065 |    5.125 |
     | U1957               | C0 v -> Y ^  | OAI211X1 | 0.122 |   5.187 |    5.247 |
     | o_out_data_r_reg_2_ | D ^          | DFFRX1   | 0.000 |   5.187 |    5.247 |
     +-------------------------------------------------------------------------------+
```

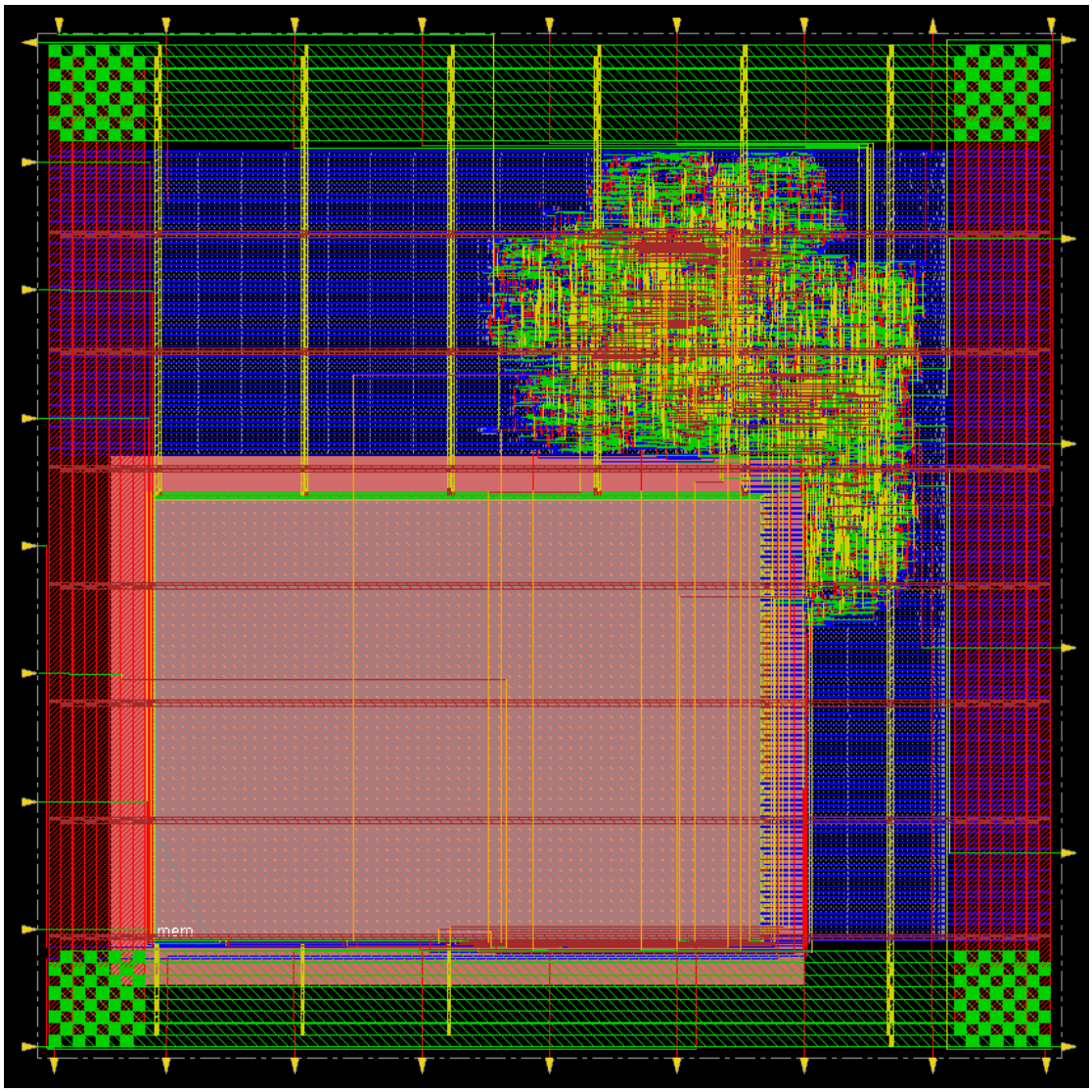
5. Attach the snapshot of GDS stream out messages. (10%)

```
Scanning GDS file library/gds/tsmc13gfsg_fram.gds to register cell name ......
Scanning GDS file library/gds/tpz013g3_v1.1.gds to register cell name ......
Scanning GDS file sram_lib/sram_256x8.gds to register cell name ......
Scanning GDS file sram_lib/sram_512x8.gds to register cell name ......
Scanning GDS file sram_lib/sram_4096x8.gds to register cell name ......
Merging GDS file library/gds/tsmc13gfsg_fram.gds ......
        ****** Merge file: library/gds/tsmc13gfsg_fram.gds has version number: 5.
        ****** Merge file: library/gds/tsmc13gfsg_fram.gds has units: 1000 per micron.
        ****** unit scaling factor = 1 ******
Merging GDS file library/gds/tpz013g3_v1.1.gds ......
        ****** Merge file: library/gds/tpz013g3_v1.1.gds has version number: 5.
        ****** Merge file: library/gds/tpz013g3_v1.1.gds has units: 1000 per micron.
        ****** unit scaling factor = 1 ******
Merging GDS file sram_lib/sram_256x8.gds ......
        ****** Merge file: sram_lib/sram_256x8.gds has version number: 5.
        ****** Merge file: sram_lib/sram_256x8.gds has units: 1000 per micron.
        ****** unit scaling factor = 1 ******
Merging GDS file sram_lib/sram_512x8.gds ......
        ****** Merge file: sram_lib/sram_512x8.gds has version number: 5.
        ****** Merge file: sram_lib/sram_512x8.gds has units: 1000 per micron.
        ****** unit scaling factor = 1 ******
Merging GDS file sram_lib/sram_4096x8.gds ......
        ****** Merge file: sram_lib/sram_4096x8.gds has version number: 5.
        ****** Merge file: sram_lib/sram_4096x8.gds has units: 1000 per micron.
        ****** unit scaling factor = 1 ******
######Streamout is finished!
```

6. Attach the snapshot of the final area result. (5%)

```
************************ Analyze Floorplan ************************
    Die Area(um^2)              : 489062.43
    Core Area(um^2)             : 290445.51
    Chip Density (Counting Std Cells and MACROs and IOs): 54.675%
    Core Density (Counting Std Cells and MACROs): 92.064%
    Average utilization         : 100.000%
    Number of instance(s)       : 8506
    Number of Macro(s)          : 1
    Number of IO Pin(s)         : 33
    Number of Power Domain(s) : 0
************************ Estimation Results ************************
********************************************************************
```

7. Attach the snapshot of your final layout **after adding core filler**. (Remember to switch to **Physical view** and make Pin Shapes visible) (10%)



8. What is your strategy for floorplanning (especially for placing the SRAMs)? What is the reason behind it? (10%)